Resorting to IMS-LD to standardize the learning process of Serious Game design in education

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***Abstract*—** Nowadays, with the challenge of the twenty first century and the effects of globalization, educational systems become constantly under pressure. The resort to face-to-face teaching and learning no longer quenches the thirst and the adaptation to the fast development of technological tools becomes crucial. The needs to serve the learners, become urgent to make learning activities more motivating, funny and engaging for the students who are continuously surrounded with every form of new technology. Serious games are one of those tools that can be considered very effective when it comes to engage and motivate the students. In serious games as well as in any e-learning tool the pedagogical issues must be well integrated during the design process. In our paper we will first of all present some frameworks that can be used to evaluate the effectiveness of serious games in educational field before trying to standardize the teaching learning process. We will demonstrate how the IMS learning design can be used during the design process of educational games to facilitate and encourage the collaboration between games designers and the pedagogues for the sake of creating adaptive learning experiences.

***Keywords*—** Adaptive learning, E-learning, Education, IMS-LD, Pedagogy, Serious Games, Standardization, Video Games design.

I. Introduction

WITH the advent of the twenty-first century and its numerous challenges, video games have begun to occupy a significant place in people's lives. Different people use video games for different purposes whether for the sake of pure entertainment or for educational purposes. In fact, video games have become one of the biggest entertainment industries beating out the movie, music, and DVD industries combined, so far as sales are concerned [1]. Video games provide their users with clear goals, interaction with other players, and an experience which they cannot realistically achieve in real life. Moreover, video games are considered as an excellent way to deal with motivational enhancements. According to Yee's studies [2] gamers play for three main reasons: relationships (deriving pleasure in interacting with other gamers), immersion (identifying with game characters and living in the fantasy world of the game), and achievement (overcoming challenges and becoming powerful). No other field has experienced the same explosive growth as the computer and video game industry; which has aroused its interest in different areas other than entertainment.

With respect to their possible aims and objectives, serious games do not target merely the unique purpose of entertainment. Most significantly, they can be used for serious goals such as training, learning, communication or even physical or mental exercises. They have become a new trend in different areas including education. Today's students represent the generation that grew up surrounded by an amalgam of contexts and learning situations using video games. In this regard, serious games are recognizably considered as a promising and an effective learning medium or tool. Serious games can be used for different types of learning. The nearest at hand are problem solving activities during which the player/learner is given an amount of information and a situation where s/he is involved in a game to solve particular pre-targeted problems. Similarly, s/he uses them to identify with a character so that the player/learner knows the use of the playing context in real life, by gaining skills of practice in what s/he is learning and in specific kinds of situations s/he will need to confront. Serious games also help in adapting the teaching process according to the learner's profile. Good video games give us a glimpse about what learning might look like in the future; and if or when we decide to give up the old approaches and methods of traditional schooling [3].

As learning technologies, serious games should appropriately integrate pedagogical and learning objectives and fit within pre-established learning methodologies. Beyond elements that are inherent in every game (mechanics, game-play, rules and so on), various learning aspects need to be included; which makes the design of serious games a mind-boggling and challenging task. In this paper we will see how serious games design can benefit from existing e-learning standards. In section 2 we will briefly define serious games and discuss their effectiveness in the educational area. In section 3 we will introduce video games design, outline some standards in e-learning design before proposing an integration of serious games and IMS-LD. Finally, we conclude this article by mentioning our future work.

II. Serious Games in Education

Students, more than anyone else, feel the urgent need to keep abreast of new technologies. Today's digital students have tremendously benefitted from ICT in their schooling. Yet, the traditional basic components or constituents of school systems are still holding sway. Governments still base their school systems on pre-established curricula; and under the umbrella term 'curricula' are inherent syllabi which, in their turn, are founded on pre-established goals, standards, benchmarks and objectives. For a serious game to be successful in pedagogical terms, it has to fit within pre-established paradigms and at the same time go beyond them; which is very hard to bite on for a game designer and not easy to guarantee in all circumstances. Playing serious video games is susceptible of generating not just entertainment but learning. It can even give immediate feedback to the learner and to the overall system by allowing the player to progress at his/her own pace, by giving him/her the opportunity to explore, by trying new things and taking risks, in a safe place without being judged or ranked [4].

1. The concept of Serious Games

The concept of 'serious games' usually stands for games that are used for other purposes than pure entertainment such as education, military training, health care, and other sectors of society. The term "Serious Games" was put forward for the first time by Clark Abt in 1970 before the appearance of computer games. Clark provides the following description of serious games: "*Games may be played seriously or casually. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining*" [5]. This description is considered valid for the computer based serious games. Later, Mike Zyda who participated in the development of Americas Army defines a serious game as, "*A mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives*" [6].

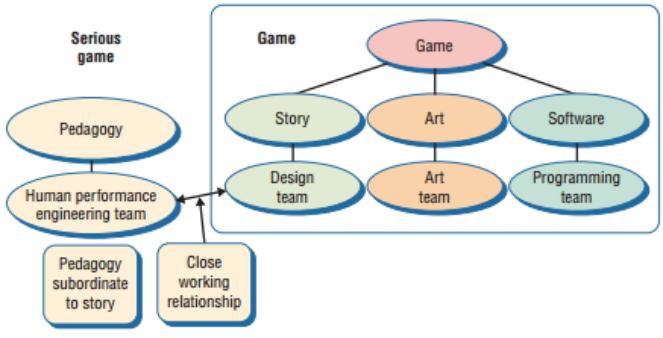

Fig. 1 Serious Games according to M. Zyda

Serious games, according to Zyda, embody more than story, art, and software. As Figure1 shows, they include pedagogy (activities that educate or instruct, elements whereby imparting knowledge or skill can be achieved). However, he claims that pedagogy must be subordinate to story and that the entertainment component comes first [6].

The literature dealing with games is throng of labels, terms and jargon. Sometimes these terms can be used interchangeably; sometimes they bear difference in nuance. The most salient and recurrent ones are: "Game Based Learning", "Digital Game Based Learning", "Educational Games", "Simulation Game" and "Edutainment". Furthermore, "Serious games" does not necessary signify video games; it can also mean regular games (board games, card games and so on). In our paper we will limit the scope of serious games to video games.

2. Serious games effectiveness in education

To claim effectiveness, serious games must combine the educational dimension which defines the learning goals and the ludic dimension which creates the engaging and the fun part of the game, while taking into consideration the pedagogical integration of both dimensions.

Traditional schooling seems no longer at stake for various reasons. It is often said to be based on the transmission of knowledge in a full-frontal way and in settings where learners are looked down on as empty vessels to be filled in with ideas regardless of their needs, likes, age and interests. In contrast with traditional schooling and with the challenges of globalization, 'Blended Learning' has become a necessity and an undeniable fact. The use of electronic media, contents and channels has become an irreversible novelty. Learning by doing, also called 'Experiential Learning', has become more than ever an urgent necessity. This shift from content-based instruction to 'Blended Learning' makes the use of 'serious games' something not just worth venturing on but a pre-requisite for school systems worldwide.

Towards the fifties of the last century, Benjamin Bloom, an educational psychologist, developed a prominent taxonomy of educational objectives; and ever since, his work predominated syllabus design and evaluation. Although Bloom's taxonomy focuses basically on cognitive sides of learning, the tasks inserted in his taxonomy touch upon affective and psychomotor sides of learning. The cognitive domain involves knowledge and the development of intellectual skills [7]. This embeds skills such as recalling or recognizing specific facts, procedural patterns, and concepts linked to

Table. I Bloom's taxonomy of educational objectives

Bloom's Taxonomy of Educational Objectives (Traditional) Skill	**Definition**	**Key words**
Knowledge	Recall information	Identify, describe, name, label, recognize, reproduce, follow.
Comprehension	Understand the meaning, paraphrase a concept.	Summarize, convert, defend, paraphrase, interpret, give examples.
Application	Use the information or concept in a new situation	Build, make, construct, model, predict, prepare.
Analysis	Break information or concepts into parts to understand it more fully	Compare/contrast, break down, distinguish, select, separate.
Synthesis	Put ideas together to form something new.	Categorize, generalize, reconstruct.
Evaluation	Make judgments about value.	Appraise, critique, judge, justify, argue, support.

the development of intellectual abilities and skills. The affective domain seeks to define the manner we handle things emotionally. It has to do with feelings, attitudes, motivations, values, and enthusiasms. The psychomotor domain includes physical movement and activities, actions, coordination, and use of the motor-skill areas.

Within the cognitive domain, Bloom identified six levels (See table 1). The levels move increasingly from simple to complex and are designed to measure student's degree of learning. Bloom's taxonomy is useful in conceptualizing instructional lessons and skills which the learner should go through from simple to complex. This can also be applicable to serious games, where game developers organize information / input in terms of game levels or sequences.

Many levels of learning, called also 'Benchmarks' -to borrow the standard based approach terms- include tasks which would go under the label of "application", tasks such as building, making, constructing, modeling, predicting and preparing. Later, Raoul A. Arreola formulated a table of learning objectives in accordance with Bloom's taxonomy [8]. He put forward more exhaustive tasks and skills to develop in students. He kept Bloom's six main categories/levels of learning objectives: knowledge, comprehension, application, analysis, synthesis and evaluation. But under every main categorization he derived detailed tasks which lend themselves to serious games in their learning /education dimensions. Bloom's taxonomy included thirty four objectives. Arreola extended on it and made it include sixty learning objectives. A brief glance at Arreola's taxonomy reveals that the main six categories of learning objectives all lend themselves to serious games in one phase or another.

A lot of questions arise when it comes to measuring the effectiveness of serious games in learning domains. So, how can we be effective and efficient while bringing a serious game to a particular learning domain? That's a leading question which generates more than one answer. James Paul Gee, one of the researchers who has studied the learning potential in computer games, has established thirteen principles/criteria that can be used to evaluate the effectiveness of video games in education [9]. These principles/criteria take into consideration the degree of motivation. That is to say how a particular game can be used to motivate and engage learners/players in learning experiences. Gee organized these principles into three categories. The first category deals with empowering learners, the second one touches upon forms of problem based learning and the third one tackles how games create a deep understanding in the learner.

- **Empowered learners**

For Gee, empowering learners is a prerequisite which can be founded on four principles: The 'co-design principle', where the learner is considered as an active agent and not just a consumer; the 'customization principle' according to which the learner must be able to customize his/her learning experience to his/her own learning style and be able to try new styles at the same time; the 'identity principle' which stands for the fact that deep learning calls for an 'extended commitment' and such a commitment is strongly optimized when people take on a new identity they value and in which they invest themselves heavily [9];and the 'manipulation principle' which aims at empowering the learner by engaging the body and the mind in the learning process.

- **Problem based learning**

While problem solving activities seem to accompany most recent pedagogies, Gee tries to systematize problem based learning by identifying seven principles. Among them, the 'pleasantly frustrating principle' according to which learners feel and get evidence that their effort is

paying off in the sense that they can see, even when they fail, how and if they are making progress [9]. The cycle of expertise principle: Each level exposes the players to new challenges and allows them to get good at solving them until they become expert and the process starts again in the next level.

Most attached to learners' needs are the two principles called: 'On Demand' and 'Just in Time' principles where the information is given "just in time" in situations where the learner can use that information and "on demand" when the learner needs it.

- **Deep understanding**

In attempt to systematize deep understanding Gee highlighted two principles. The first one is about 'system thinking'; hard problems have to do with complex systems. To be able to solve these problems the learner needs to know how to do systems thinking. The second one is about meaning as action and image: Instead of getting meaning by other words/equivalents, which is often the case in standard schooling, games give meaning with images, actions and experiences. Meaning is visualized and contextualized.

Searching in the literature, we found many frameworks that help in evaluating serious games effectiveness. Among them we could cite de Frietas and Olivier (2006) who introduced a Four Dimensional Framework for evaluating games based learning. This framework helps in evaluating the potential of using games and simulation based learning in educational practice, and in providing more critical approaches to those games and simulations [10].

Tutors who have the intention of inserting games in their teaching activities face many decision-making questions. Which game to use for supporting a specific learning context? Which pedagogic approaches to fit within the learning activities? Or, what is the effectiveness of using that specific game?

The Four Dimensional Framework limits four basic facets or dimensions to be seriously considered while approaching game design. The first one is the "Context" where the learning/playing is taking place. The second dimension is about the "Learner" and focuses on the learner preferences and attributes that can influence the learning effectiveness such as the learner's age, level, background and style. The third one concentrates on "Mode of representation" that applies to the interactivity, the levels of immersion and fidelity used in the game or simulation. This dimension serves also as a method for briefing and debriefing before and after a serious game, which increases and fortifies the learning experience. The last dimension is "Pedagogy" that advocates the participants view upon methods, theories, models and frameworks used to enhance learning practices.

The four dimensions are complementary and interdependent and should not be considered as separate entities; they rather reveal the significance of how each dimension relates and maps to each other to produce, support or inhibit the particular learner or learner group's experience [10].

III. Standardization of Serious Games Design

Again with the concern of guaranteeing effectiveness and efficiency, the design of good educational serious games should set up educational effectiveness as a goal to be duly integrated in the design process. However, this isn't sufficient; the process of serious games design must be standardized to ensure a good communication and a common understanding of both parts (educators and game designers). Serious games can benefit from standards in e-learning to unify the jargon of game design and to standardize the teaching-learning process.

In this section, we will propose a standardization of the teaching-learning process using IMS-LD and we will explain how both of IMS-LD and video games can be combined to create adaptive learning experiences.

1. Video games design

For Salen and Zimmerman game design is the process by which a designer creates a context to be encountered by a player, from which meaning play emerges [11]. They consider the role of a game designer as threefold: 'designing game play', 'conceiving' and 'designing rules and structures' susceptible of resulting in an experience for players. They propose schemas to understand the game design. These schemas are Rules, Play and Culture. They defined games design fundamentals that include the powerful connection between the rules of a game and the play that the rules engender, the pleasures games invoke, the meanings they construct, the ideologies they embody, and the stories they tell.

Doug Church a game designer announces this, "The design is the game; without it you would have a CD full of data, but no experience." [12]

"The art of Game Design", a map of elements established in Jesse Schell's book, show important considerations when designing a game and the relationship between them (see figure 2). He defines video games design as follows: "Game design is the act of deciding what a game should be" [13]. He considers as the main objective of game design creating an experience that starts with an idea and concerns a player. In fact, games create all kinds of wonderful, amazing and unforgettable experiences. Games consist of elements: mechanics, story, technology and aesthetics each of these elements is important and they are related closely to the player's experience. The experience that the game offers takes place in a world, the imaginary place that exists in the imagination of the player. While playing a game, the player must feel free and must feel that s/he controls the

game in his/her own way which makes it easy for him/her to project his/her imagination in the world of the game and thus to be immersive in it. For this purpose the designer must ensure that the players do things of their own free will.

The experience a game is susceptible to offer to game players/learners is primary to the design process, without it the game is meaningless. This experience is not unique to games; we can find it in books or movies. The difference is that these experiences are linear whereas the experiences of games are more interactive. The game designer has to give to the player the control over the events that the experience gives. In this stage of games design, other fields are consulted like psychology or anthropology to try to figure out the player's heart and

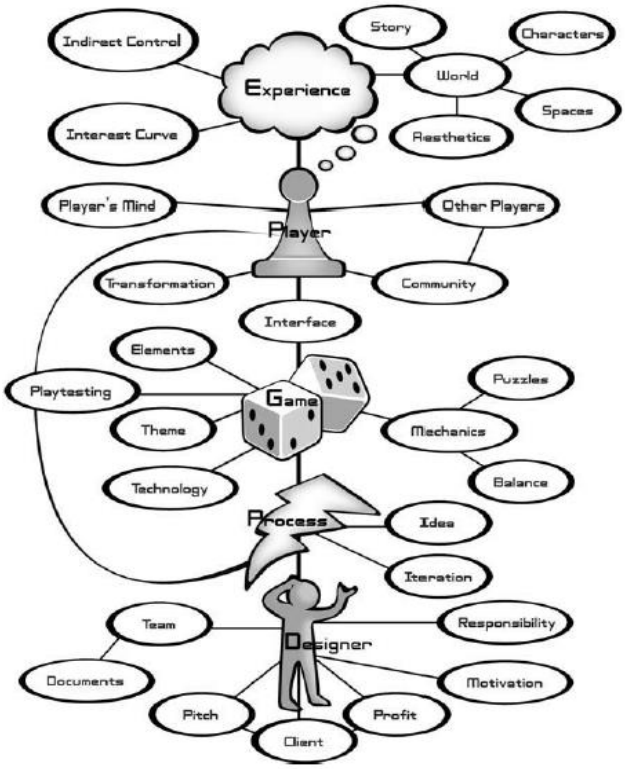

Fig. 2 Game design map (from the Art of Game Design [13])

mind, affect and cognition. While designing this experience the game designer must take into consideration some factors like surprise, fun and curiosity.

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Video games are made for a player and exactly for a specific audience. To design a game for this audience, the game designer must think as they do, try to feel what they feel and understand what they want in a game. He must project himself/herself in the mind of the player. The best way to do that is to spend as much time as possible with the target audience and to watch them playing to figure out what they enjoy in a game. This is the strategy of pre-design immersion.

A game consists of mechanics, the rules of the game. They constitute the goals of the game, how players can or cannot achieve those goals and what happens as they try to achieve them [13]. According to Jesse Schell mechanics should be in balance (adjusting the elements of the game until they offer the adequate experience) and must support puzzles to make the player stop and think of the right decision to make [13].

To create experiences, games must embed stories. These stories happen in a world, the imaginary place where a game takes place. This world contains spaces and characters called also avatars which the player controls in the game and which s/he identifies with. These characters help to create a powerful experience.

The look and feel of this world is defined by its aesthetics, if the game has beautiful artwork it makes the world of the game look real; which makes the experience more effective. Technology is what makes the game possible; it constitutes the physical objects that allow the realization of the game. Technology is the essential medium in which the aesthetics take place, in which the mechanics will happen, and through which the story will be told.

To design a good video game all the elements that have been cited before in addition to the ones that are shown in figure 2 must be taken into consideration.

Educational Games design draws on the elements dwelt on above and bears a great affinity with commercialized video games. But, it needs the pedagogical integration of the learning content.

2. E-learning standards

Why is standardization crucial to serious game design? It permits, among other significant effects, 'interoperability', 're-usability', 'durability' and 'accessibility'; and those are undeniable criteria of systematic and well-established game design. In this section we will shortly revisit the literature on existing e-learning standards to determine the one which will form the basis of our work.

A. IEEE LOM

IEEE LOM is an e-learning standard developed by IEEE (Institute of Electrical and Electronics Engineers). The standard specifies the syntax and semantics of Learning Object Metadata, defined as the attributes required to fully and adequately describe a learning object [14]. It includes pedagogical attributes such as; teaching or interaction style, grade level, mastery level, and so forth. In addition, LOM encapsulates the Dublin Core [15] elements. The Dublin Core metadata standard describes a wide range of networked resources [16]. The Dublin Core standard includes two levels: Simple and Qualified. Simple Dublin Core consists of fifteen elements (the title and the subject of the resource, the description of its content and so on); Qualified Dublin Core includes three additional elements (Audience, Provenance and Rights Holder), as well as a group of element refinements [16].

B. SCORM

The Shareable Content Object Reference Model (SCORM) [17], published by the Advanced Distributed Learning (ADL) project, is a standard for e-learning content. The SCORM specification is a collection of specifications profiles based on various other standards and specifications. It determines how online learning content and Learning Management Systems (LMS) communicate with each other. SCORM defines how to create "sharable content objects" or "SCOs" that can be reused in different systems and contexts.

SCORM specifies how to package learning objects as SCOs so that they can be aggregated, stored, copied, moved, archived, uploaded and eventually delivered to a user. SCORM package its content using IMS Content Packaging [18]. SCORM consists of sub-specifications:

- **Content Aggregation Model:**

The Content Aggregation Model defines how the course content, which will include one or more SCOs, should be packaged, deployed to, and delivered via any SCORM conformant learning management system (LMS).

- **Run-time Environment:**

The SCORM run-time specification controls how the LMS launches content and how the sharable content objects communicates with the LMS.

- **Sequencing and Navigation:**

SCORM Sequencing and Navigation define the ability of a learner to navigate from one learning object to another and the sequence in which learning objects may be experienced by a learner. Sequencing determines what navigational controls and options are available to the learner.

C. IMS Learning Design

IMS Learning Design (IMS-LD) [19] was developed by the Open University of the Netherlands. IMS-LD is a meta language that is based on the Educational Modeling Language (EML).

The IMS Learning Design specification supports the use of a wide variety of pedagogies in online learning. Rather than trying to apprehend the specifics of each pedagogy it provides a generic and flexible language. This language is designed to enable many different pedagogies to be expressed [19].

Learning Design specifies three levels of implementation and compliance (see figure 3). Level A contains all the vocabulary needed to support pedagogical diversity. Level B adds properties conditions, monitoring services and global elements to Level A, which enables personalization, adaptation, sequencing and feedback. It can be used to direct the learning activities as well as record outcomes. Level C adds Notification to level B which is triggered by an outcome and can make a new activity available for a role to perform.

Fig. 3 Three levels specification of IMS Learning design

In comparison with SCORM and IEE LOM, IMS Learning design is very effective in the support of adaptive learning experiences and it can easily be understood by both educators and video games designers, that's why we have based our work on it.

3. Integration of IMS-LD and serious games

The top priority aim of this paper is to use IMS-LD during the design process of serious games so that the game designer team and educators/pedagogues find an appropriate field of collaboration in making an effective educational serious game.

To avoid going astray, serious game designers have to guarantee a reasonable and well-founded outset. Doubtful and shady areas should be avoided. For level A, as shown in the level specifications above, users constitute the first agents to be catered for. They constitute the WHO of the game design operation. Their interests, motivations, age, gender, level of proficiency in the domain targeted, as well as other attributes constituting their exact profile, should be seriously born in mind and closely investigated by the game designer and the serious domain specialists such as educationists, methodologists or teaching practitioners.

As for learning activities in level A, they constitute the 'WHAT' to base the game (or the learning content) on. They could touch upon any teaching or education area or

subject. They need, however, to be supplemented by extra-activities that would possibly go beyond them. Hence the inclusion of support activities in level A. The idea of having support activities lends more flexibility to IMS-LD and makes it easily fit within educational or other serious contexts.

Catering for the environments, as mentioned in level A, is also crucial to avoid any inconveniency so far as the 'WHERE' of the game design is concerned. Users and their communities are the clients to be served; and together with their values they constitute the environment where the game design and implementation takes place.

So far as resources are concerned, they touch above the material and physical support without which a learning content cannot be transmitted. In a traditional face-to-face context resources can be the textbooks, the board, the audio-visual aids, the physical setting (seating), the official guidelines, the teacher's book, the labs, the court and so on. While the term 'resources' in a blended learning or e-learning context can refer to any behind-the-screen hardware, software or data support and share.

One might broadly conclude that IMS-LD level A features and video game design elements bear a lot in common. In IMS-LD level A we find pre-requisite components such as roles, activities, environment, resources and acts while in video games we find players, characters, mechanics world of the game and stories. The affinity between the two can help in facilitating the communication between educators, pedagogues and the serious games designer team. IMS-LD can be considered as a unified jargon between the two parts. It allows interoperability, easy exchange in design and preparation and a compatible way of describing educational input as well as its assessment. However, the learning process is always dynamic and in a state of flux. A mere common labeling and determining of entities and components is not enough. This is basically the reason why IMS-LD should be continuously integrated in an on-going process of design and adaptation of learning experiences in serious games.

IMS learning design draws on a wide range of modern pedagogical approaches that are used today, active learning, collaborative learning, adaptive learning, personalization, dynamic feedback, runtime tracking, ePortfolios and alternative assessment [20]. In fact with IMS-LD the author of the teaching material can specify detailed learning design components. In other terms s/he can specify the desired type of learning activities and their sequences (including adaptation and personalization aspects), interaction between different persons in different roles and the interaction between these roles and learning activities/tasks and learning services/outcomes [21].

The strong points about IMS LD lie in the fact that it is able to achieve six main types of adaptation [22]: 'learning flow based', 'content based', 'interactive problem solving support', 'adaptive user grouping', 'adaptive evaluation' and 'changes in run-time'. In addition the basic and crucial structure provided by Level A, the elements of Level B can serve as the real key for adaptation. These elements combine properties with conditions and other features encouraging flexible content and a learning flow. The elements in Level B which provide more straightforward support to adaptation in Units of Learning are properties, conditions, global elements, calculations and monitoring services.

- **Properties**

Properties are taken as variables to store values. There are many types of properties: local, global, personal and role. When several properties are defined around a category they can be grouped in the property-group property.

- **Conditions**

IMS-LD is able to define 'if-then-else' rules to change the value of a property or to show and hide one element. It refines the visibility of activities and environment entities for persons and roles.

- **Global elements**

Global elements provide a communication flow between the 'imsmanifest.xml', where the different levels of IMS-LD are set-up, and other XML files. Mainly, they can get an input from the user and they can show a value of a property. Furthermore, they can manage DIV layers in XHTML, for instance to show and hide specific content.

- **Calculations**

IMS-LD is able to make some basic calculations (sum, subtraction, multiplication and division) and some combination of a number of them in a row, to get a more complex formula, like a simple average, for instance.

- **Monitoring services**

The specification allows monitoring any kind of property assigned to a user or a role, for instance. In order to start this action, firstly the component monitor must be set-up inside an environment and later the property can also be traced.

Through a combination of 'properties', 'calculations', 'conditions', 'global elements 'and 'a monitoring service', a range of adaptive methods can be modeled; for instance, properties allow making user's 'features', 'group features', and adaptation to 'stereotypes [23].

We notice in commercialized video games that they are very adaptive. Good video games offer adaptive experiences for each type of players. They offer different skills and different methods to achieve goals and solve problems. Furthermore, they adjust the difficulty depending on the player progress in the game. During the

design process of a video game the level designer designs the different levels of the game. In each level s/he predetermines the right level of challenge, the accurate amount of reward, the right amount of meaningful choice, and all the other ingredients that make a good game [13].

There are many works that define the adaptive side of video games in educational contexts, one of them is the customization principal [9] put forward by James Paul Gee who states that the learning experience offered by an educational game is customizable depending on the learner's profile.

Video games can match the player/learner decisions. For instance, it can be detected noticeably if the user is stuck trying to solve a puzzle, and this serves as a clue in lessening the difficulty of the task slightly. [24]

The integration of IMS-LD during the design of educational serious games can facilitate the design process and enhance the learning objectives. This integration helps also the adaptation of the educational content to the profile of the player/learner.

The integration of IMS-LD is illustrated and visualized in figure 4. The educators/pedagogues create the learning content/scenarios that are organized later in a set of activities.

The 'roles' of the game are the player/learner himself/herself, 'acolytes' that will help and guide the player/learner to achieve the goals of the game and other characters like enemies. To permit conversations/interactions between the different roles, the game designer can consider a communication mechanism like a chat system, forums or wikis. These roles perform predetermined activities in the environment of the game using available resources. The aspects that characterize each role are also predetermined by the game design team.

The game records the outcome of the different activities. The reached outcome can serve in further adaptation and adjustment of the learning content. In fact it can be used to set properties values. These properties represent the learner's progression in the game (the completed activities), the results of evaluations, the learning style of the player/learner and so forth.

The adaptive mechanism will use these properties in the conditions established and agreed upon by both the pedagogues and the game design team to continue adapting the levels/content of the game (see figure 5). It's an on-going process. Conditions which would go under the form of 'If-Then-Else' rules will use Boolean

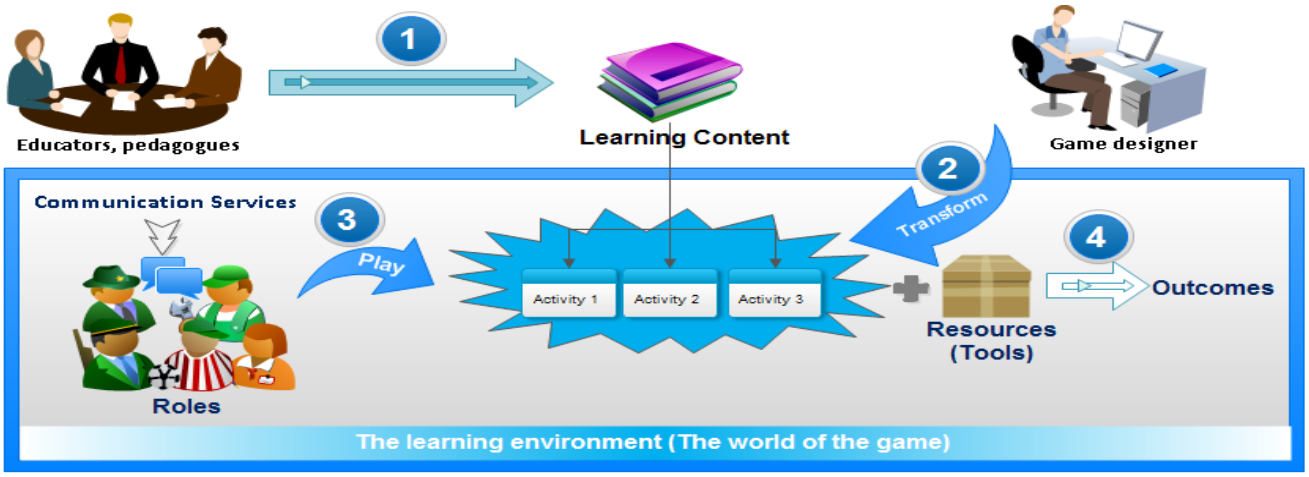

Fig. 4 Using IMS-LD specifications during Serious Games design

These activities are carried out in a specific order and are transformed by the game designers to add the fun part, for example to transmit information to the learner/player the game designer will transform it to 'hints collection', to make the learner/player practice this information the game designer can bring situations/contexts (depending on the type of the game) where the learner/player is supposed to act/play to solve problems. And for the evaluation part the game, the designer can come up with a final situation like the so-called "Beat the boss" situation where the learner/player will use all the skills that s/he has developed so far to beat the boss. To achieve these activities the game designer makes available for the player/learner a set of tools.

expressions on properties to personalize the learner/player experience and refine his path of learning. For example, depending on the outcomes of one level the game will adjust the next one; and instead of letting the player/learner perform all the activities of the level, only the basic activities will be implemented in the game until the player masters them all.

Evaluating learning outcomes is not an isolated task. It is, rather, a continuous phase and component acting as a determinant factor of designing adequate serious games relevant to given learning. In some learning situations those learning outcomes can be used by the teacher to appropriately integrate the serious games in a pedagogic

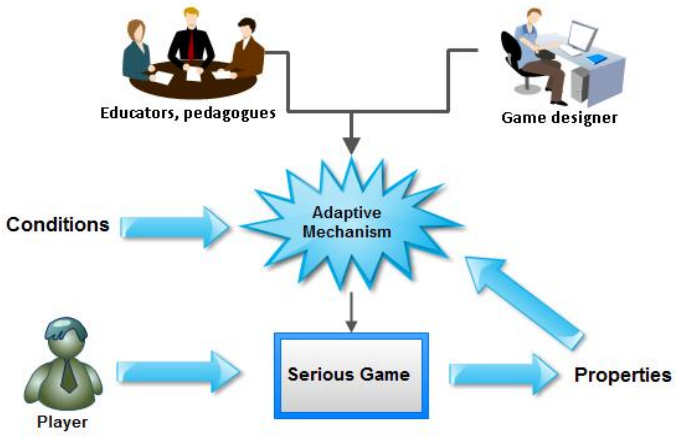

Fig. 5 The adaptive mechanism for serious games

activity; very much like the Four Dimensional Framework [10] we have mentioned which can be taken for guide and reference. In sum, our approach proposes to evaluate serious game effectiveness through two ways: The first one relies on storing properties that concern the learner/player and that will be constantly used to adapt a game in a continuous process, while the second one relies on matching integration with a teaching activity, the main goal and the heart of playing a particular serious game.

IV. Conclusion

A lot of ink has been spawn on serious games in the last decades in areas such as education. In fact, educational serious games may be considered as one of the cornerstones of 21st century education. To be effective, these serious games must combine both the ludic part and the learning content while taking into consideration some pedagogical aspects during this combination. The integration of both the fun dimension and the educational dimension requires a close collaboration between the game design team and educators. To facilitate their communication and their collaboration the serious games design process must be standardized. In this perspective, we have tried in our paper to standardize some aspects of this process. To do so, we have firstly studied the game design process to understand the important components that constitute video games. We have revisited the literature on existing e-learning standards to choose the adequate one that can be used during the process of serious games design.

We opted for IMS Learning Design specification since 'IMS-LD level A' features and video game design have a lot in common. In this sense, we can use IMS-LD as a common language that can be understood by both educators and video game designers. IMS-LD is considered as a powerful tool when it comes to modeling adaptive learning experiences using the elements of level B; videogames are also considered as ideal tools to adapt the content. In this paper we propose to conceive a standardized adaptive mechanism which will be made by both educators and game designers and that will be based on the adaptive aspects of both IMS-LD and video games. This mechanism will take 'properties' as an input. These properties contain the outcome of the activities of the game and they represent the learner's progression in the game or the results of evaluations reflecting the learning style of the player/learner. The same properties will also be used by conditions/pre-requisites established by both the pedagogues and the game design team to constantly adapt the levels of the game.

Our future work will consist of the establishment of this adaptive mechanism. To do so, we will need firstly to determine the different components and features of this mechanism and to fix its outcome (properties, conditions). We also expect to make a prototype to apply this mechanism to a special type of game for a specific audience before its generalization.

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